Tuning holes in two-dimensional Photonic Crystal microcavities: a predictive Fabry-Perot model

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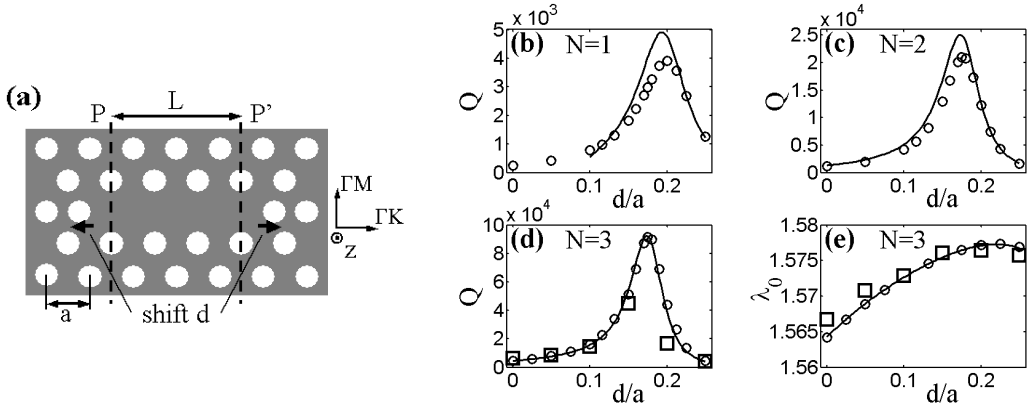
Recently, several works on two-dimensional (2D) Photonic Crystal (PC) microcavities have evidenced the importance of finely tuning the PC geometry at the cavity terminations to achieve high quality factors with wavelength-sized modal volumes. For instance in [1], Q factors of 45,000 have been experimentally achieved through a surprising 10-times Q enhancement induced by a fine shift (60 nm) of the holes surrounding the defect region. We have studied the light confinement in these cavities with a classical Fabry-Perot (FP) model. This approach is original and in comparison with the analysis performed in [1], which is presently being debated [2,3], it leads to a different interpretation of the effects of hole tuning. The existence of an analytical expression for the Q factor highlights new physical effects, namely an improved mode-profile matching at the cavity terminations [4] and a slow wave effect in the cavity.



Validation of the FP model. (a) Top view of the investigated cavities formed by filling N holes in a 2D PC. (b), (c) and (d) Q-enhancement for N = 1, 2 and 3, respectively. Comparison between experimental data taken from [1] (squares), rigorous calculation results (circles) and FP predictions (solid curves). (e) Resonance wavelength red-shift for N = 3.

[1] Y. Akahane, T. Asano, B.S. Song and S. Noda, *Nature* **425**, 944 (2003).
[2] C. Sauvan, P. Lalanne and J.P. Hugonin, *Nature* **429** (6988), (2004).
[3] T. Asano and S. Noda, *Nature* **429** (6988), (2004).
[4] C. Sauvan, G. Lecamp, P. Lalanne and J.P. Hugonin, *Opt. Exp.* **13**, 245 (2005).